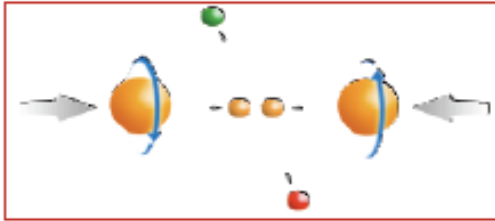


Prepare STAR as a first-stage eRHIC Detector (eSTAR)

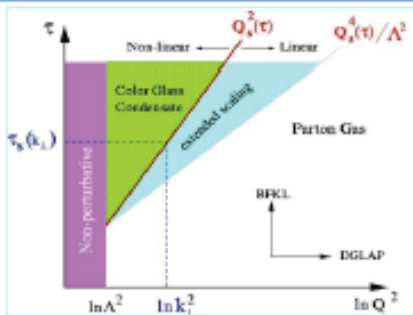
Zhangbu Xu

BNL



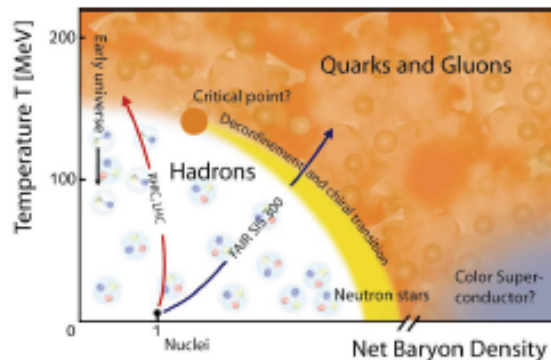
Polarized $p+p$ program

- Study *proton intrinsic properties*



Forward program

- Study low- x properties, search for **CGC**
- Study elastic (inelastic) processes (pp2pp)
- Investigate *gluonic exchanges*



1) At 200 GeV top energy

- Study *medium properties, EoS*
- pQCD in hot and dense medium

2) RHIC beam energy scan

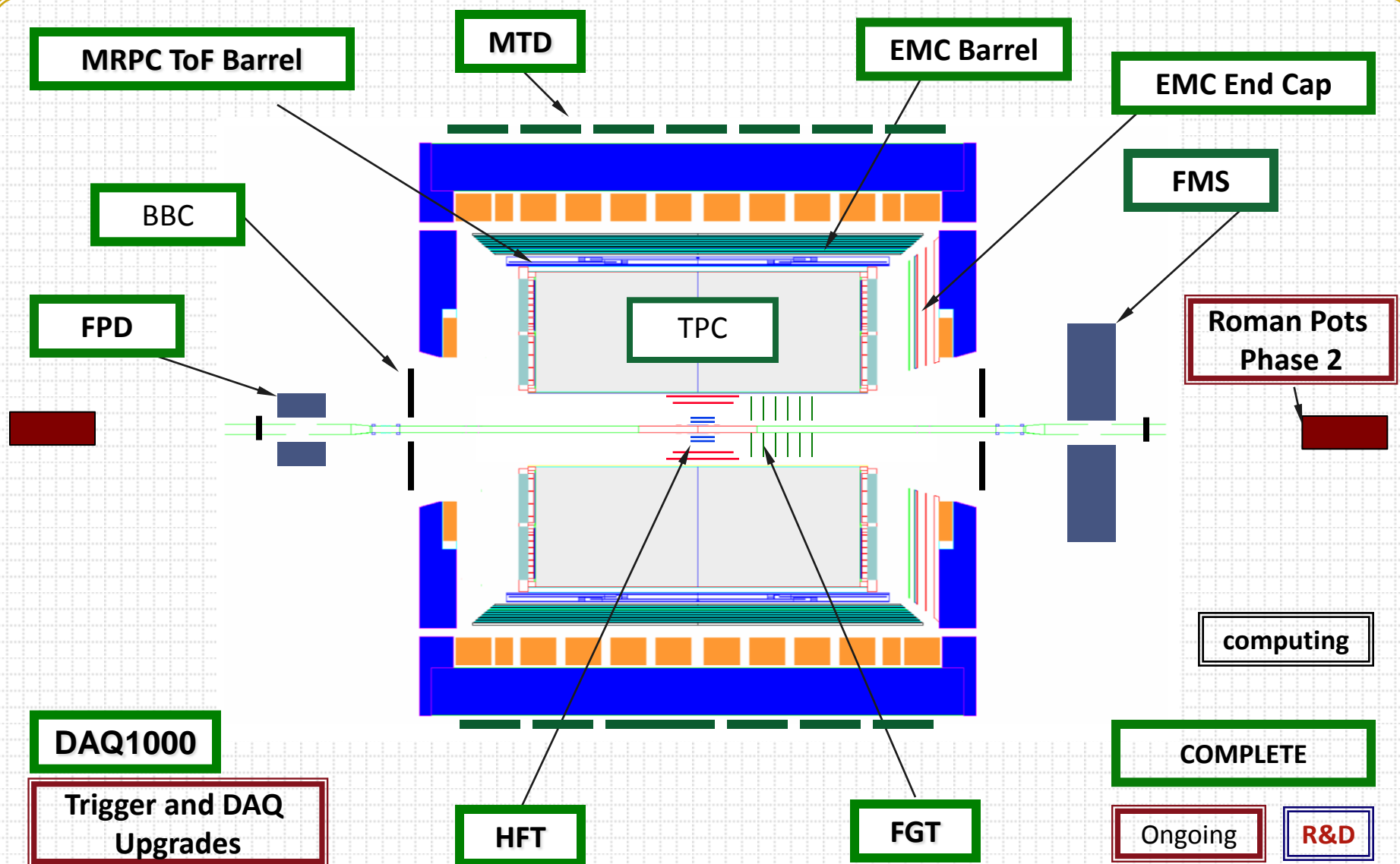
- Search for the **QCD critical point**
- Chiral symmetry restoration

Near Term

- Forward GEM Tracker
 - 60% complete this year. 3 layer GEM with APV chip readout
- Heavy Flavor Tracker
 - Thin pixel CMOS in collaboration with IPHC.
- Muon Telescope Detector
 - Approved project in construction phase.
 - Base on long MRPC technology in coll. with China and electronics developed for STAR TOF

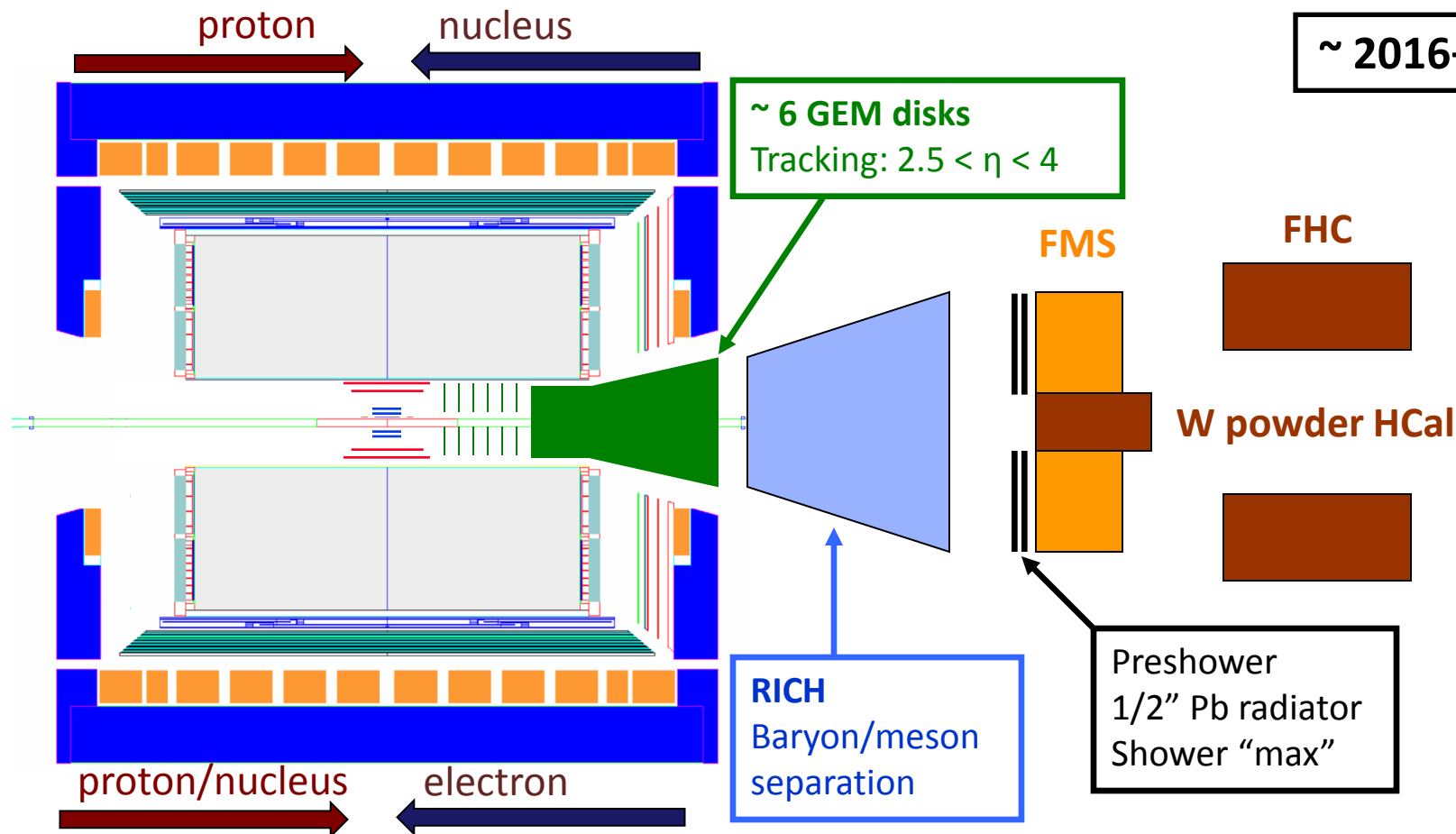
See Flemming's talk

STAR Experiment as of 2014



See Flemming's talk

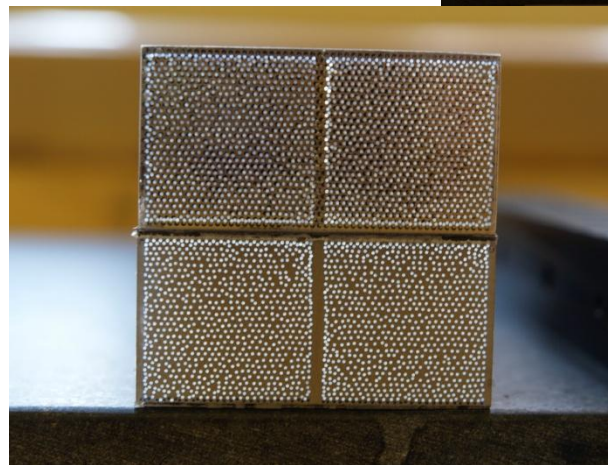
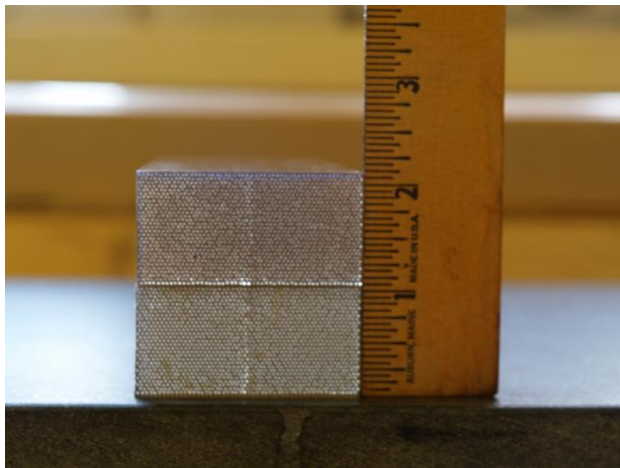
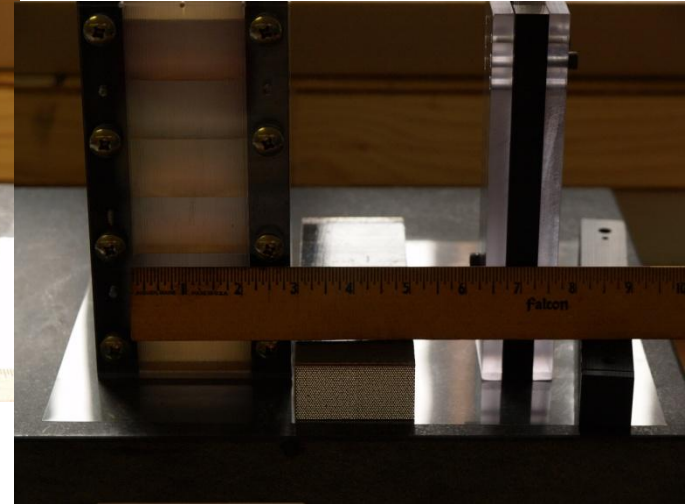
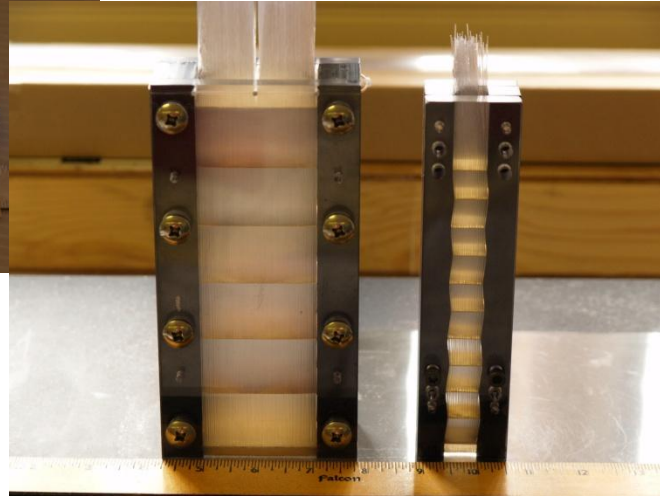
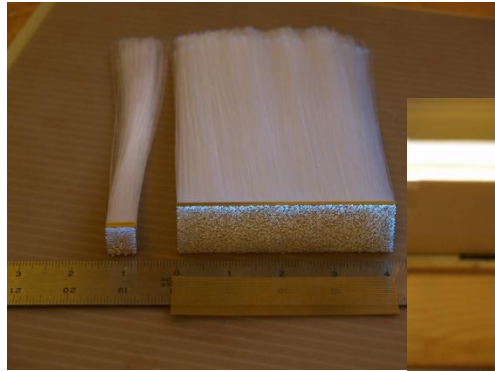
STAR forward instrumentation upgrade



- Forward instrumentation optimized for **p+A** and **transverse spin** physics
 - Charged-particle tracking
 - e/h and γ/π^0 discrimination
 - Baryon/meson separation

See Flemming's talk

Spacordion Tungsten powder with fibers: WCAL



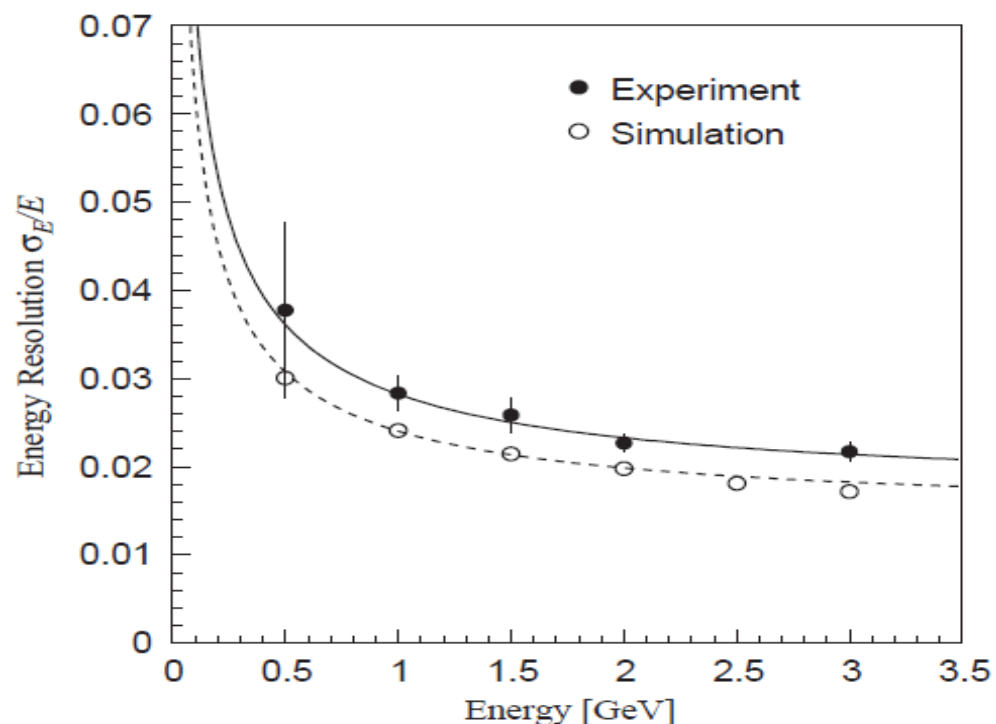
Approved EIC R&D project
from May 2011,
UCLA, TAMU, PSU

R&D proposals: <http://drupal.star.bnl.gov/STAR/future/estar-task-force>

Crystal Calorimeter (BSO)

Crystal	Density (g cm ⁻³)	Rad. length (mm)	Decay time (ns)	Peak emission (nm)	Relative light output	Price (\$/cc)
BSO	6.80	11.5	~ 100	480	0.04	13-18
BGO	7.13	11.2	~ 300	480	0.10 – 0.21	> 40
PWO	8.28	8.9	~ 10-30	410 - 450	0.003	10-13

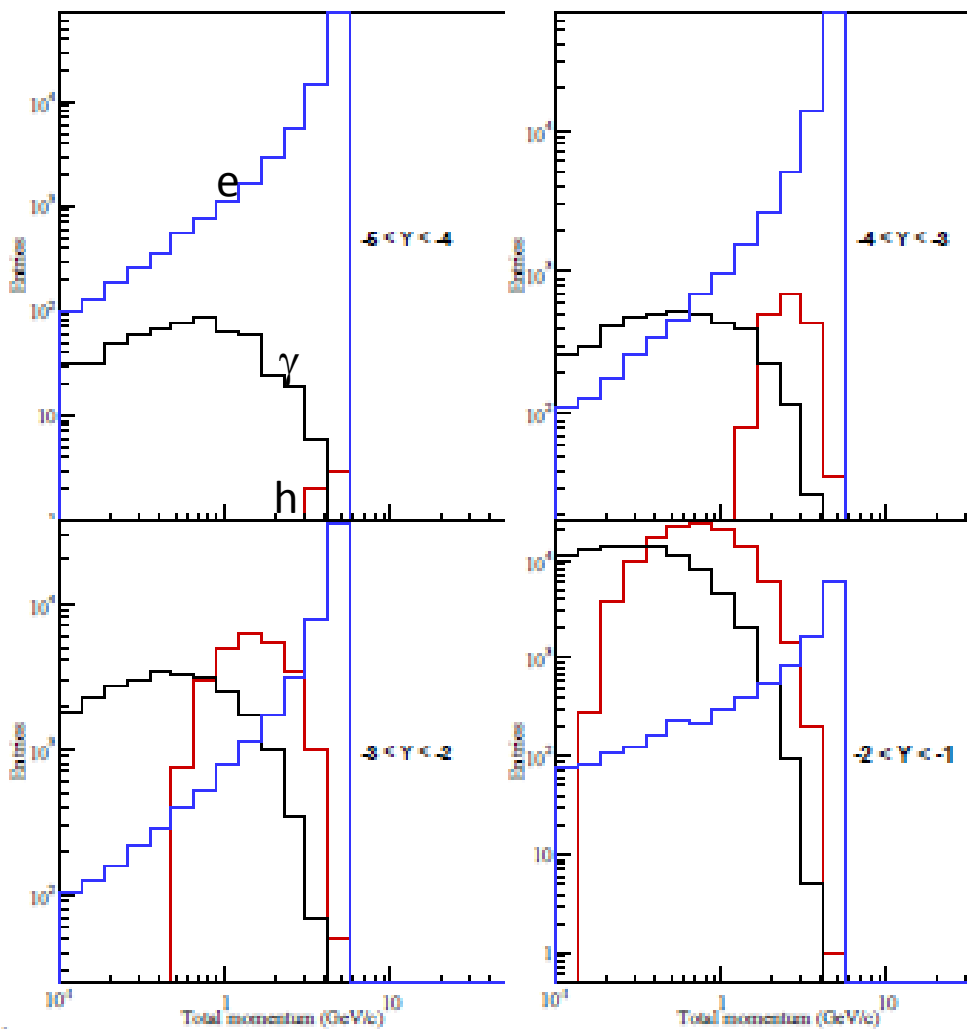
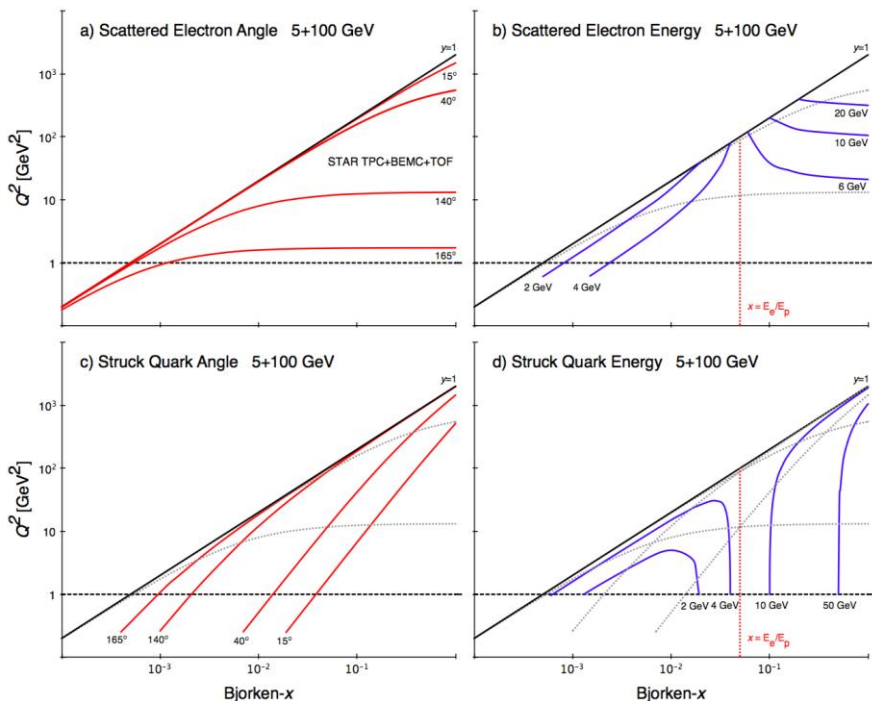
- **Very Forward Electron Detection ($\eta < -3$)**
- BSO is produced by replacing Ge in BGO with Si, the material cost for BSO reduced by x3-4.
- Collaborators: USTC, SINAP, THU
- Vendor: Shanghai SICCAS High Technology Cooperation
- R&D proposal submitted to BNL/DOE



First Stage eRHIC kinematics

INT report (arXiv:1108.1713) Fig.7.18.

Ernst Sichtermann (LBL)

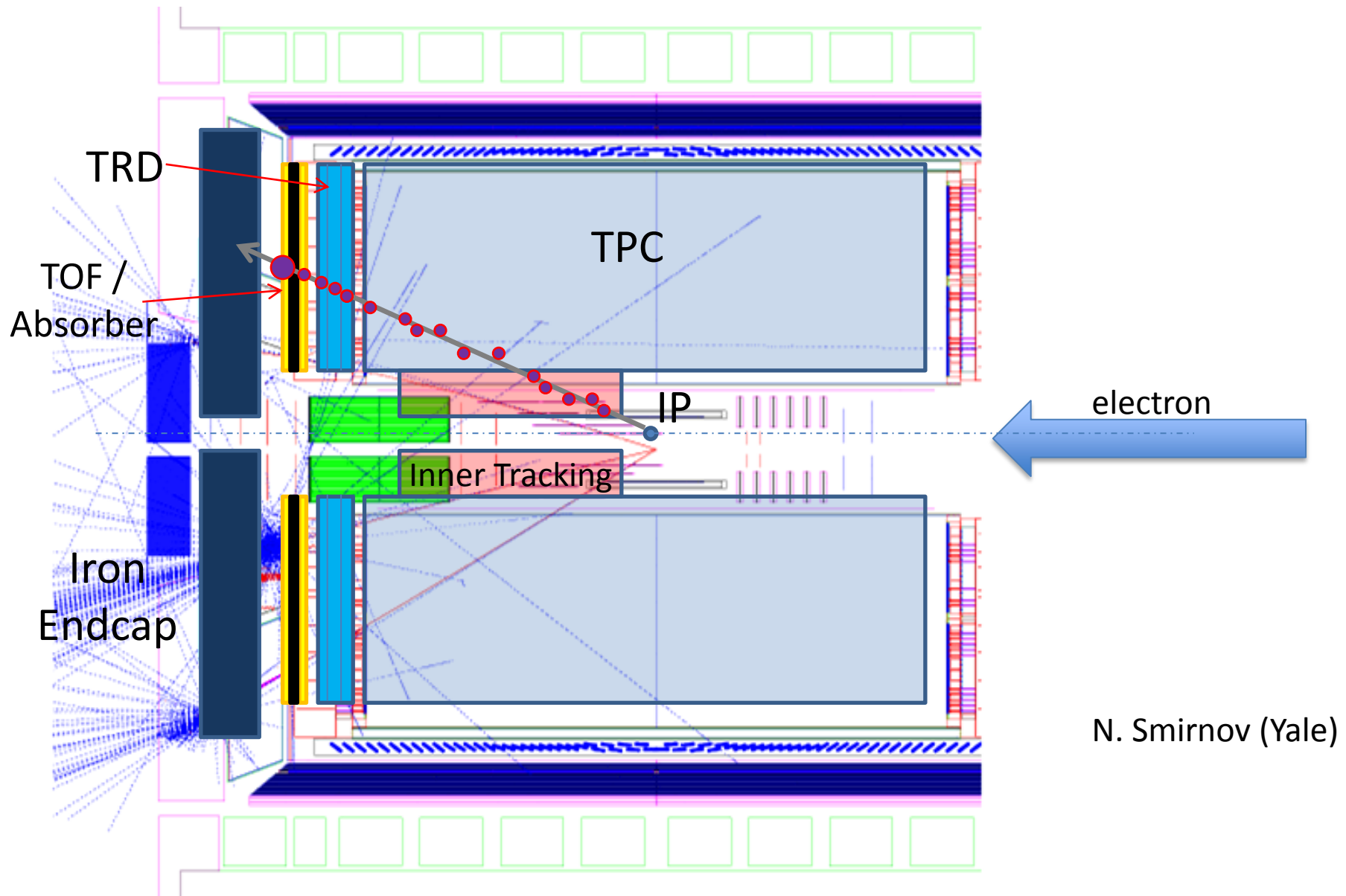


Electron coverage: $1 > \eta > -2.5$
 PID e/h: 1000
 Low material: photon conversion

STAR Concept

- Large Coverage
- Low Material
- Electron and hadron ID with gas detector and TOF, EMC
- Extend this concept to hadron direction
 - GEM tracker (FGT++)
 - Cherenkov
 - Spacordion
- Extend this concept to electron direction
 - Reinstrument inner TPC
 - MiniTPC (GEM based?)
 - TRD+TOF

Conceptual Configuration



N. Smirnov (Yale)

Electron Identification (dE/dx+TOF)

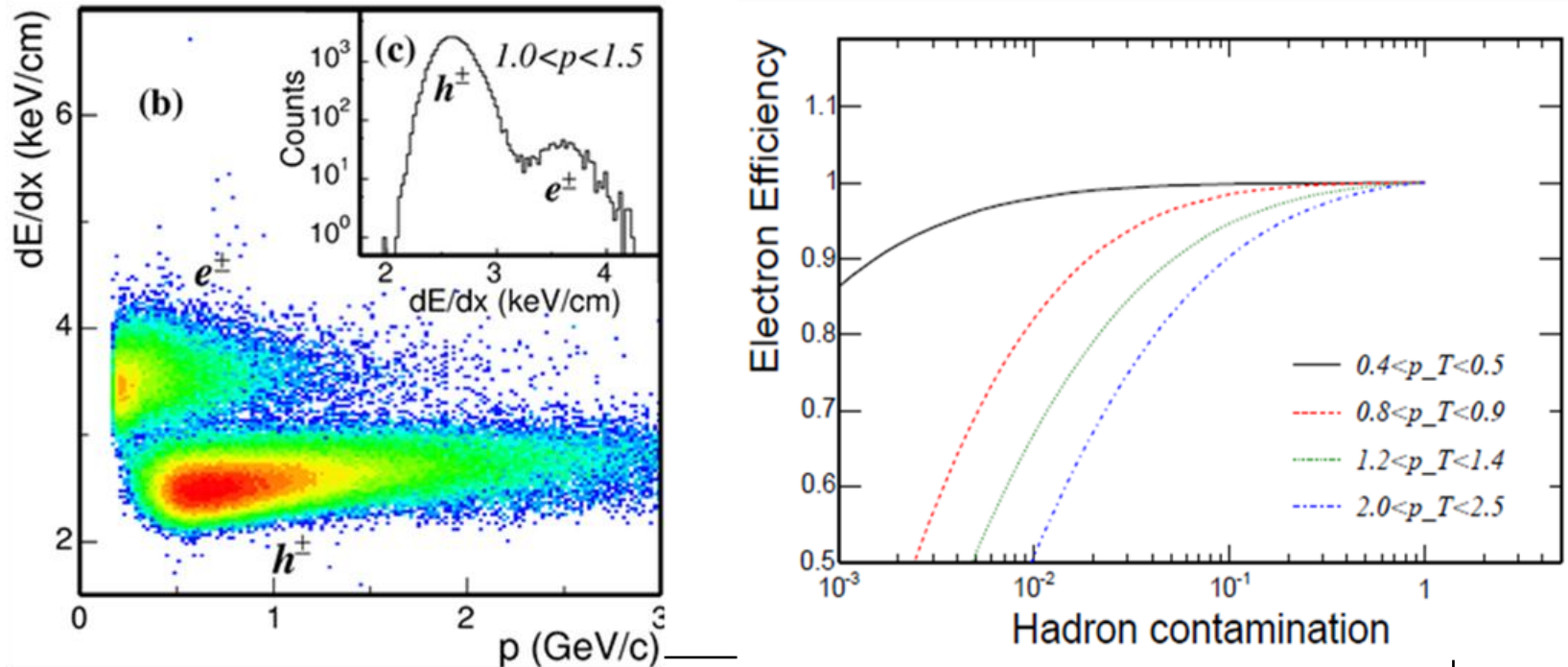
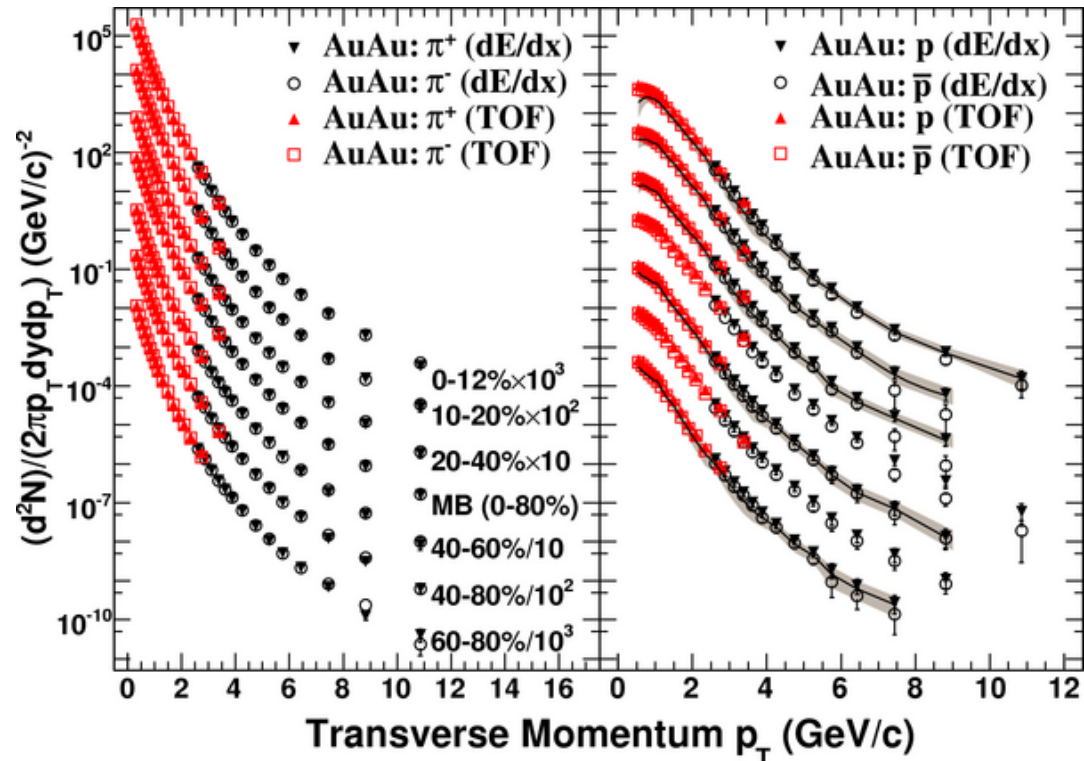
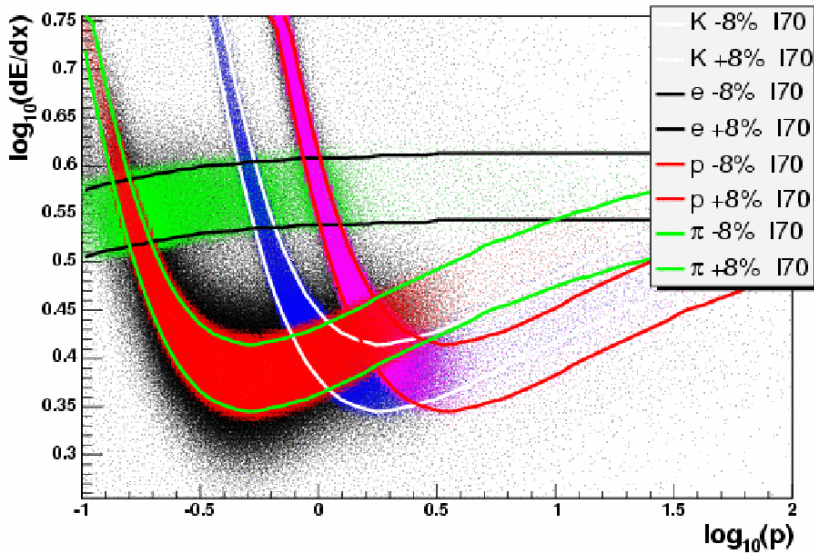


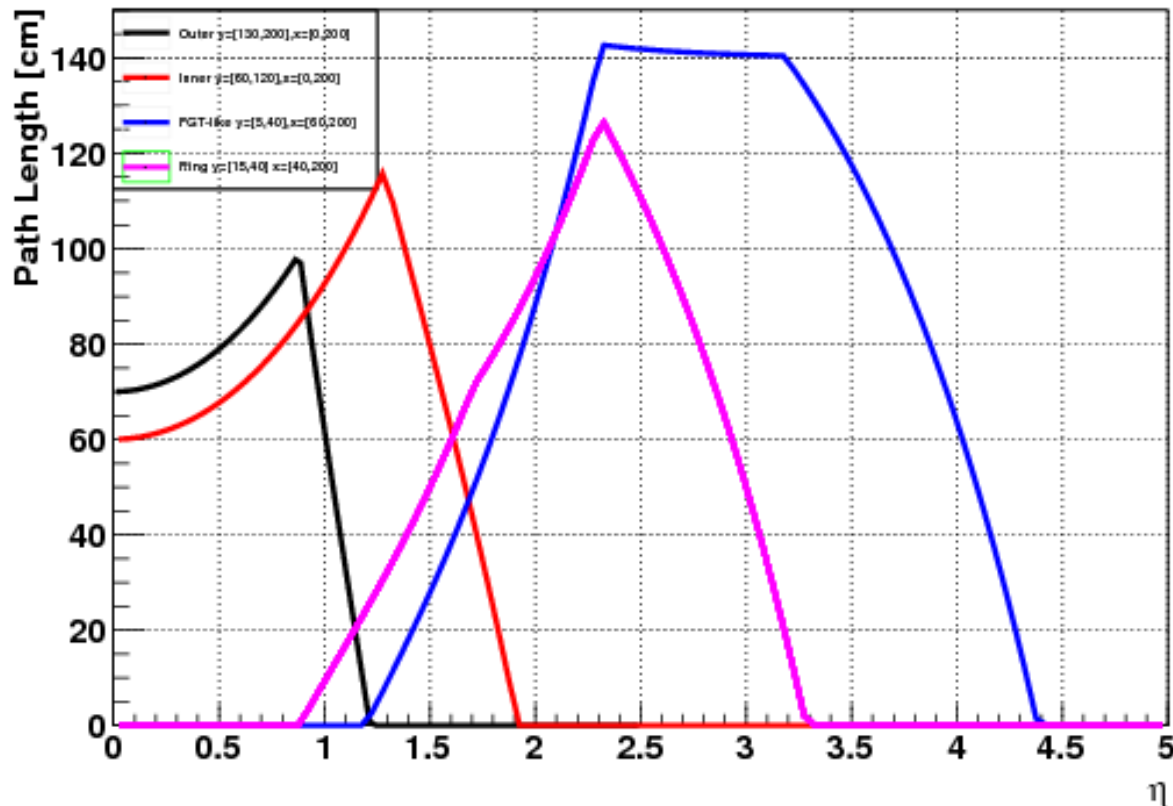
Figure 9. The dE/dx measured by STAR TPC as a function of particle momentum, with velocity cut by TOF, and (right panel) the electron efficiency after dE/dx cut as a function of hadron contamination in different p_T range.

Hadron PID



dE/dx, relativistic rise, TOF

Extend pathlength in Gas Detector

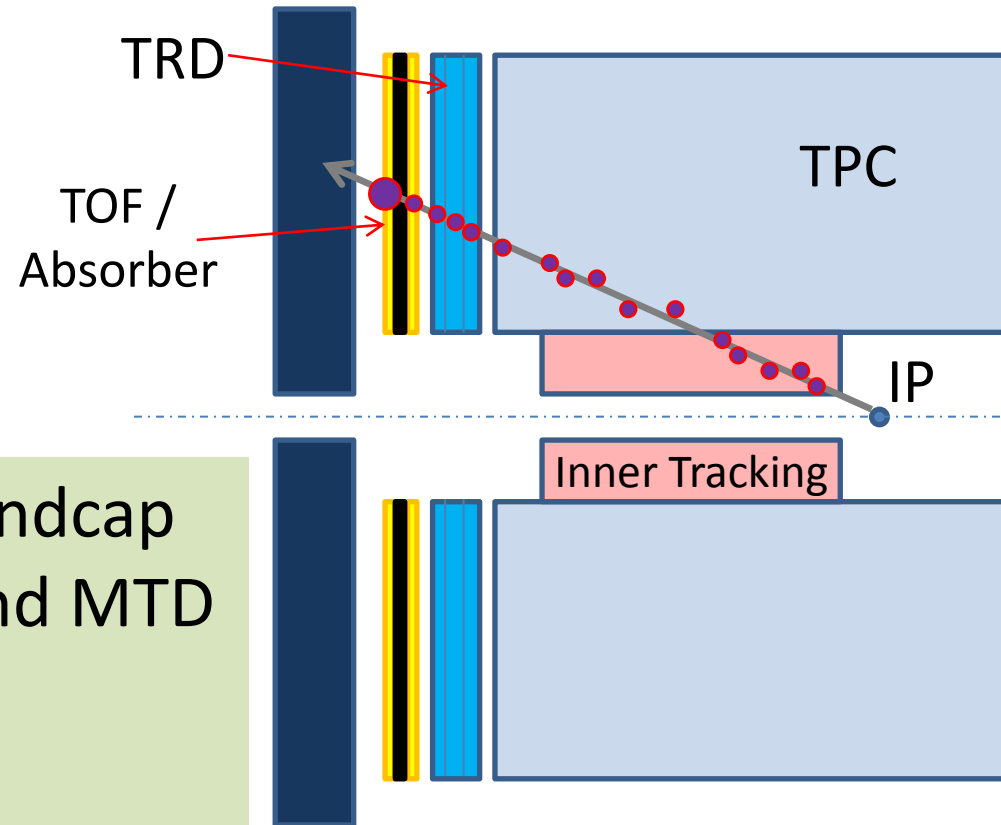


James Dunlop (BNL)

Fully Instrument inner TPC sectors
Install MiniTPC (GEM based [+CsI])
Twice the current pathlength at mid-rapidity
see other talks on R&D of miniTPC

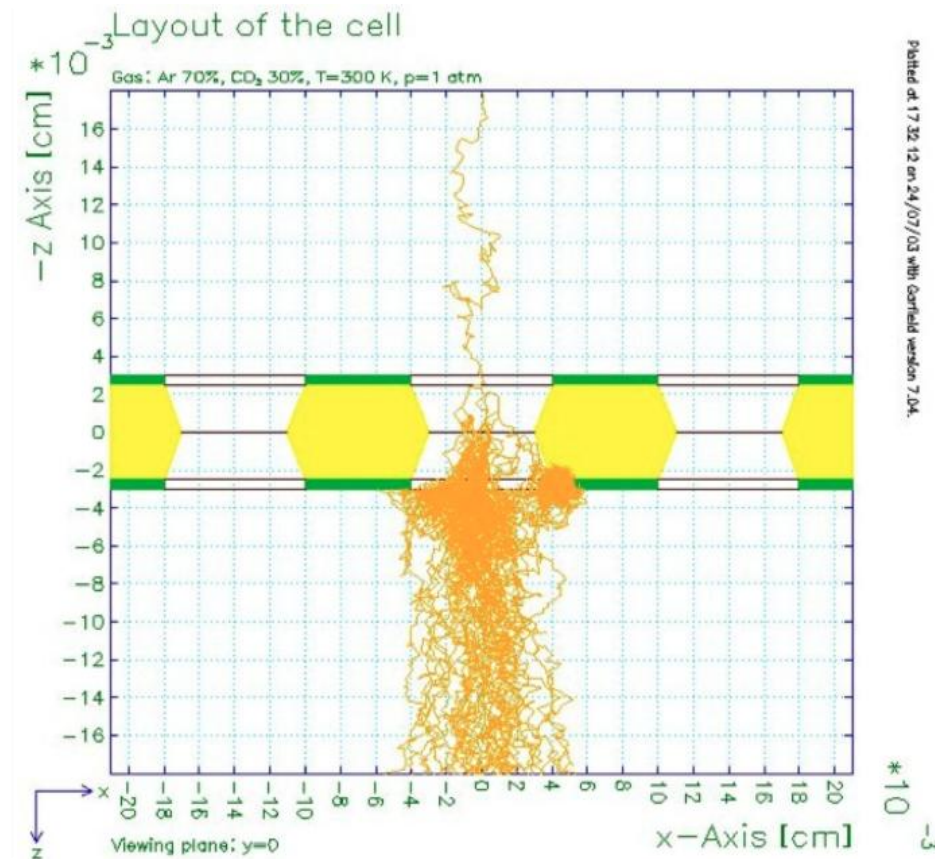
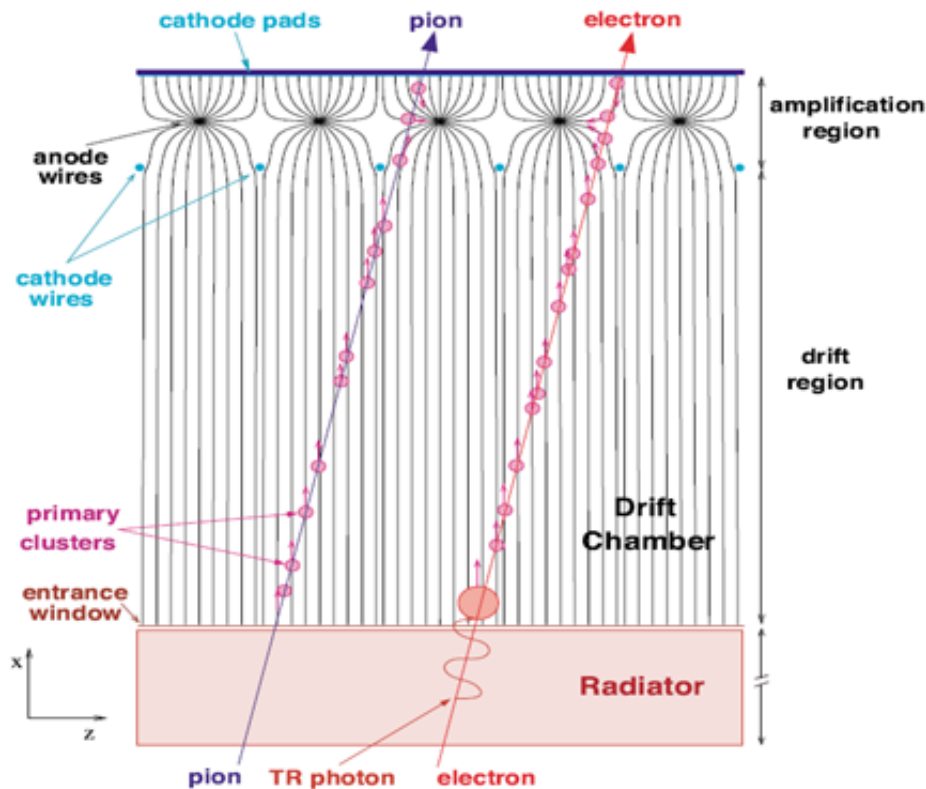
TRD+TOF at Endcap ($-2 < \eta < -1$)

- Inner tracking
 - TPC (endcap region):
TRD +
TOF/Absorber sandwich
- Within $< 70\text{cm}$ space inside endcap
 - TOF as start-time for BTOF and MTD
 - TOF + dE/dx for electron ID
 - TOF for hadron PID
 - Extend track pathlength with precise points
 - High-precision dE/dx (Xe+CO₂) TRD



Ming Shao (USTC)

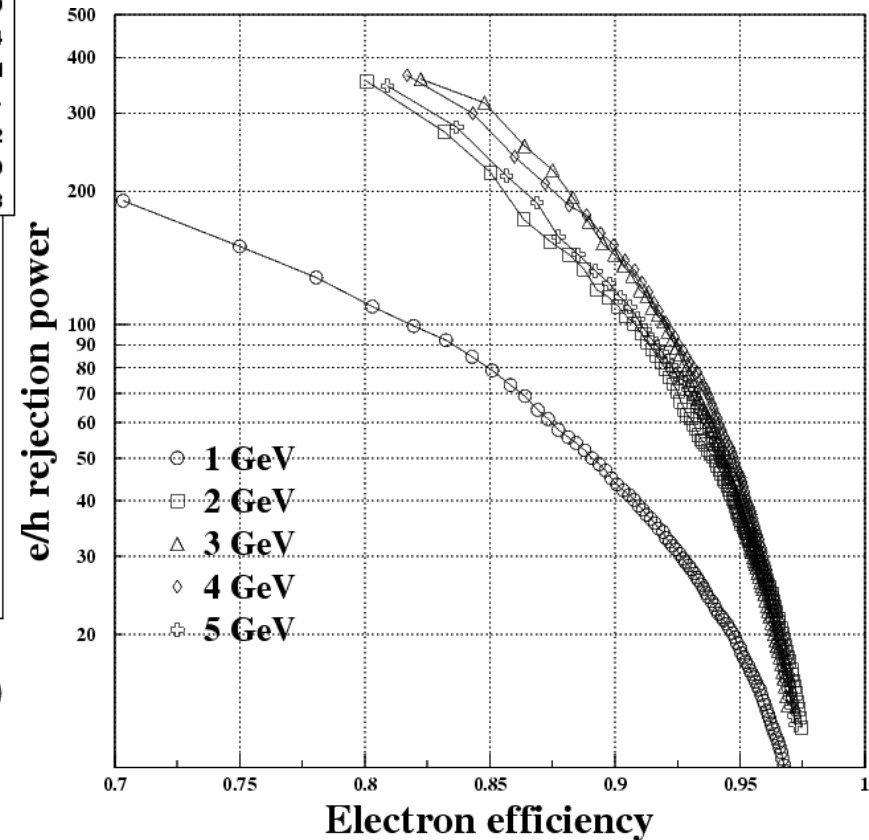
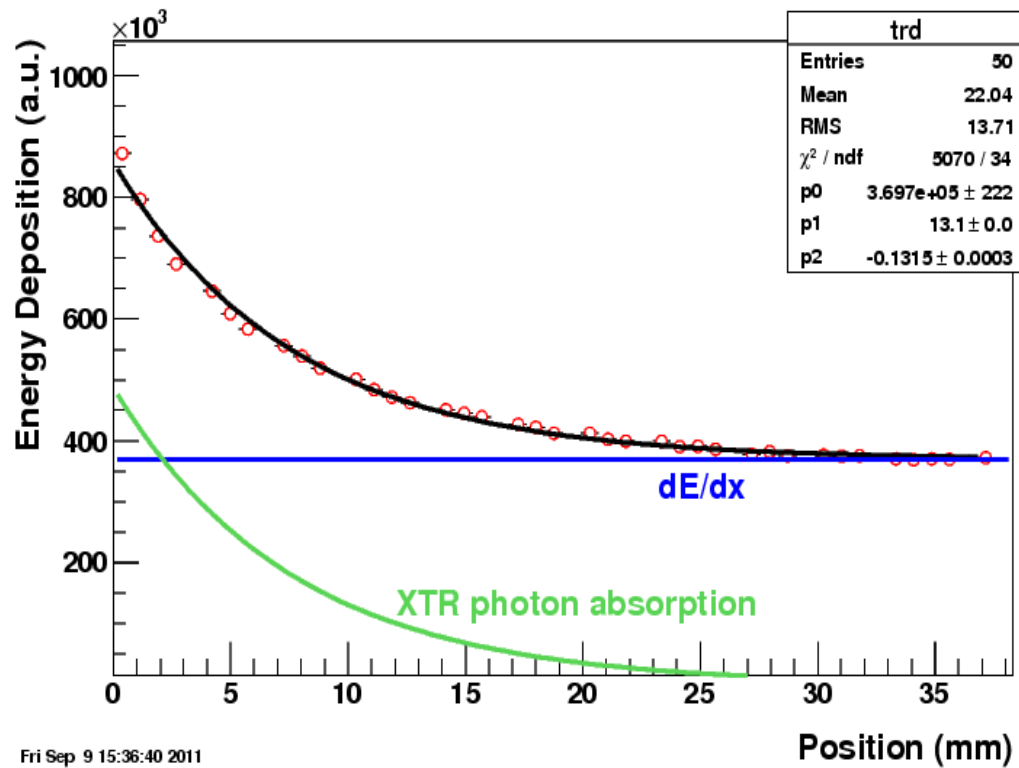
R&D on GEM based TRD



dE/dx with Xe+CO₂
position resolution
TRD gain

Collaboration: VECC/India, USTC/China, BNL, Yale et al.
Proposal submitted to EIC R&D committee

Additional dE/dx and tracklet



dE/dx and TR signals for electron and hadron discrimination
High-position tracklet for hadron momentum reconstruction

Electronics

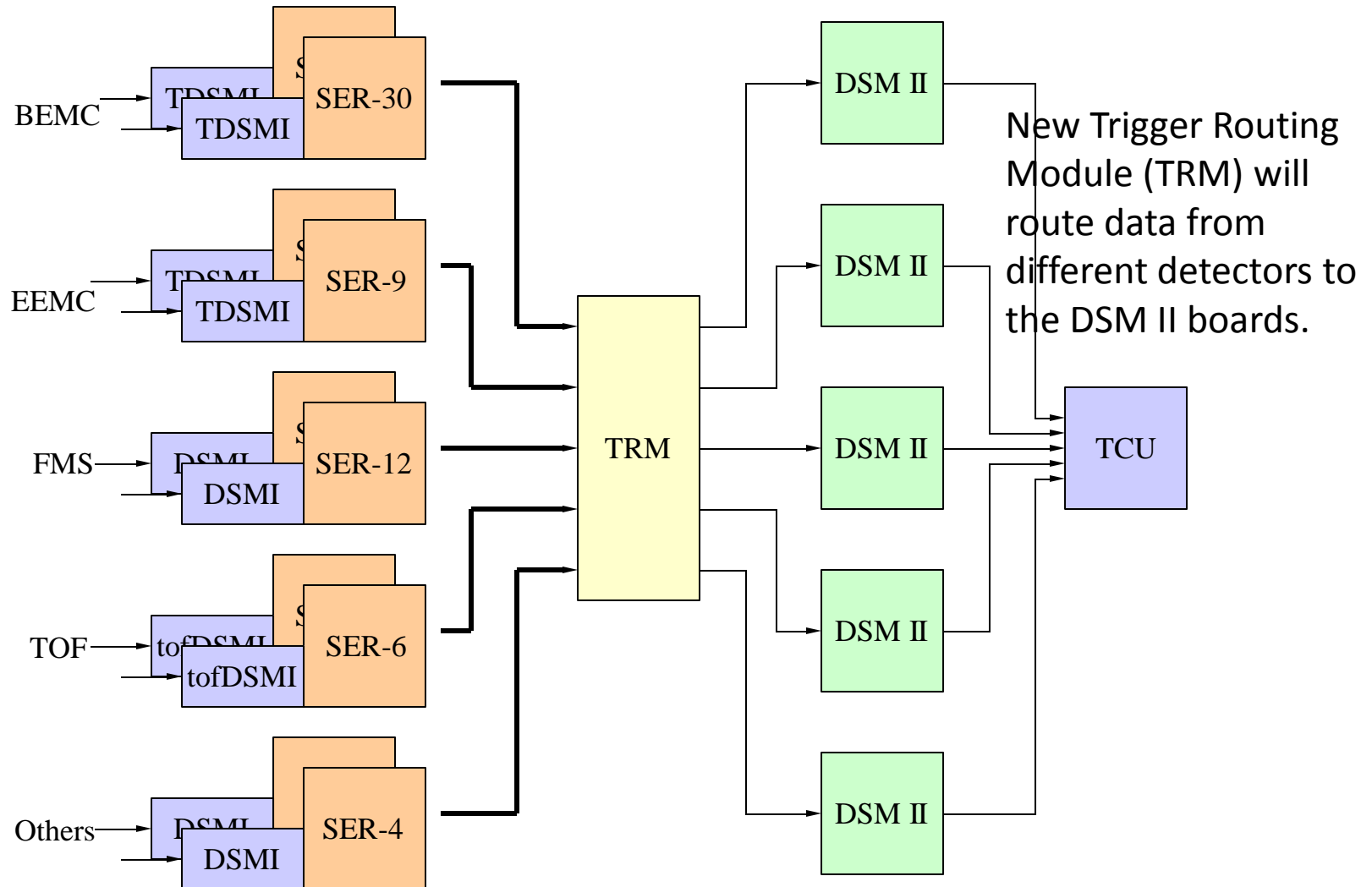
- TPC Altro;
TOF HPTDC;
FGT APV
- All out of production
- Need new electronics in 10 years!

BNL, LBL, IU, UT, Rice, MIT

Triggering Components

- Trigger is another issue since the clock changed to eSTAR, major changes in triggers are required (DSMII may do the job). CBM has adapted so-called triggerless scheme (similar to the idea of TOF HPTDC)
- This may be worthwhile pursuing.

Maximal Upgrade – Option B



Summary

- STAR is planning for the next two decades.
- There may be areas of common interest that should be discussed.
- miniTPC (+CsI), Cherenkov, TRD, TOF, WCAL, BSO, Roman Pot, polarimetry; Electronics, Trigger.